Tanzania Journal of Science 44(3): 46-60, 2018 ISSN 0856-1761, e-ISSN 2507-7961


# THE PLANT SPECIES COMPOSITION, DIVERSITY AND NATURAL REGENERATION OF INDIGENOUS TREES IN THE DISTURBED RUVU SOUTH FOREST RESERVE, TANZANIA

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## ABSTRACT

*Ruvu Forest Reserve is among coastal forests in Tanzania that has been impacted by the increased anthropogenic activities. It was determined the plant species composition, diversity and indigenous trees regeneration growth size structure in the degraded Ruvu South Forest. Transect method was used to collect data that were treated using t-test. A total of 110 plant species distributed among 38 families were recorded such that Holarrhena pubescens, Hymenocardia ulmoides, Millettia micans, Ochna mossambicensis, Pseudolachnostylis maprouneifolia and Strychnos madagascariensis were the most common trees in moderately disturbed site, whereas Albizia versicolor, Pteleopsis myrtifolia, Pterocarpus angolensis, Antiaris toxicaria, Diplorhynchus condylocarpon and Terminalia kaiserana dominated in the highly disturbed site. The Shannon's diversity index (2.3 ± 0.06) was significantly higher in moderately disturbed sites than 2.1 ± 0.1 in the highly disturbed site. The poles/shrubs and coppices were the dominant growth sizes with no significant difference between sites than trees and seedlings of which their densities were significantly different between the two sites. Trees in highly disturbed sites had diameter sizes at breast height between 10cm and 40cm and beyond these sizes were missing because of selective exploitation as opposed to moderately disturbed site with representative individuals with diameter sizes beyond 50cm. These observations imply the negative impacts of anthropogenic activities on the plant community composition and the capacity to regeneration naturally under heavily degraded condition. Adequate interventions are necessary to allow the degraded Ruvu South Forest recover through natural regeneration to safeguard the coastal forests biodiversity.*

## INTRODUCTION

Ruvu South Forest Reserve is among the existing fragments in the coastal forests in Tanzania and part of the of the former extensive forest ecoregion known as Zanzibar-Inhambane phytochorion (White 1983, Karyn *et al.* 2000). The coastal forests cover the Eastern Africa Coastal ecoregion and are distributed among four countries namely Somalia, Kenya, Tanzania and Mozambique (Burgess and Clarke 2000). The coastal forests are spread up to a maximum of 1100 m altitude from the sea level depending on the ecological conditions but excluding the mangrove forests which are referred to as 'maritime' areas (White 1983). They are heterogeneous groups of isolated forests, highly fragmented, small and patching that covers an area of 700 sq. km particularly in Tanzania (Burgess *et al.* 2000, Mligo 2010). The fragments are very distinctive and are very important in conservation paradigms due to a very high level of local forest endemic plant species that have become vulnerable to degradation and the recently drastic changing coastal climatic conditions (Burgess and Clarke 2000, Mligo 2010, Mligo *et al*. 2011).

Ruvu South Forest Reserve has been recognized as an important biodiversity conservation sanctuary because of high plant diversity characterized with endemic species to include *Combretum harrissii*, *Leptactina oxyloba*, *Millettia micans* and *Croton steenkampianus* as well as *Solanum ruvuensis* a rare species that was previously grouped among extinct plants (Vorontsova and Mbago 2010). Despite of its high level of plant species endemism, Ruvu South Forest Reserve has continued being degraded following a long term anthropogenic activities such as cultivation, pit-sawing, forest fires, firewood collection, pole cutting and very heavy pressure for charcoal making from the neighboring villages and coastal towns (Mlandizi, Kibaha, Bagamoyo, Mkuranga and Dar es Salaam city). A study by Gwegime *et al.* (2013) provides evidence on the contribution of anthropogenic activities in the degradation of the forest that between 2008 and 2010 a deforestation rate of 7% on average per annum for charcoal making was observed in Ruvu South Forest Reserve.

The grown demand for plant resources from Ruvu South Forest has been caused by a dramatic increase in the human population particularly the percentage of households that are using charcoal as the only available fuel option. Further evidence in recent years indicated an increasing rate of habitat degradation such that the previously pristine and biodiversity rich forests have changed to savanna woodlands and the existing savanna woodlands have changed into shrublands and grassland (Mligo *et al.* 2011). This culminates to a critical proportionately declining in forests biodiversity which could ultimately lead to loss of a number of plant species in fragile ecosystems including coastal forests in the very near future. The negative impacts of anthropogenic activities in Ruvu South Forest Reserve varied among locations where some parts were moderately degraded while other parts were in a heavily degraded such that none of the forest parts remained pristine. It was determined the impacts of anthropogenic activities on the plant species composition, diversity and the indigenous trees regeneration growth size structure in the degraded Ruvu South Forest Reserve.

## MATERIAL AND METHODS

### Description and location of the study area

Ruvu South Forest Reserve is located in Kisarawe District, Coast Region in Tanzania (Fig.1). It is found between latitudes 6º 53ˈ - 7º 03ˈ S and longitudes 38º 46ˈ- 39º 02ˈ E. It was gazetted in 1967 as a forest reserve covering the land surface area of 350 km$^2$. It is found at an elevation of 120 to 260 meters above the sea level and it is 50 km South – West of Dar es Salaam. Ruvu South Forest Reserve is bordered with 10 villages namely; Mpiji, Soga, Kibwemwenda, Bokomnela Chakenge, Mtamba, Kazimzumbwi, Kisanga, Kola sub village and Kifuru (Clarke and Dickinson 1995). The rainfall pattern in the area where the forest is located is similar to the general coastal climatic condition that has been supporting plant communities in the coastal forest under the influence of the Indian Ocean. The coastal climate is controlled by movement of the Inter-Tropical Convergence Zone (ITCZ) between 20$^o$ south to north about the Equator. The ITCZ represents several subsystems which help in understanding the variability of the local climate and the way it influences the plant species composition and distribution pattern (Marchant *et al*. 2006). The climate is monsoonal with an average annual rainfall below 1000 mm yr$^{-1}$ (Clarke & Dickinson, 1995). The rainy season falls between March and June and the short rains between September and November and hence bimodal (Burgess *et al.* 2000). However the rainfall around Ruvu South Forest has drastically decreased over the last ten years (Hall *et al*. 2004), consequently greatly influenced ecological characteristics within the forest.

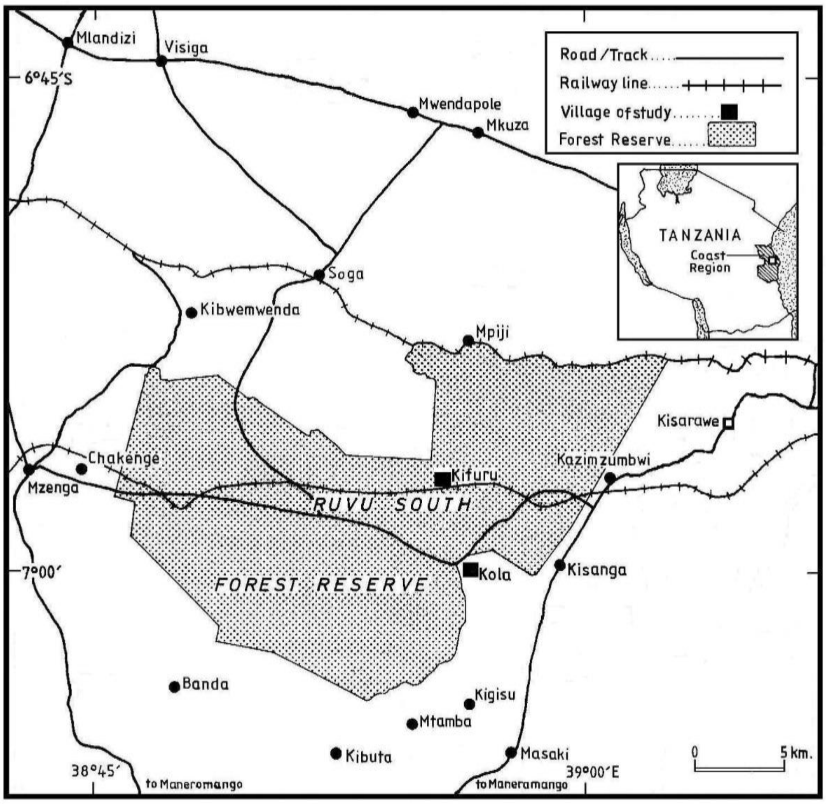


**Figure 1: Map showing the location of Ruvu South Forest Reserve and the bordering villages**

**Sampling procedures**

A preliminary survey was carried out to familiarize with vegetation communities within Ruvu South Forest Reserve. Then the forest was subdivided into two sampling sites based on the level of anthropogenic disturbance where the one established close to Kifuru village was classified as the highly degraded site and the second was the moderately disturbed site established at the edge of Kola sub village running to the interior of the Ruvu South Forest Reserve. Classification of the sites into levels of disturbance was based on a six point scale (0 – 5) (Mligo 2011). Thus, 0 means no disturbance, 1= (1-20% largely natural with little human interference), 2 = (21- 40% less disturbed), 3 = (41 - 60% moderately disturbed), 4 = (61 - 80% highly disturbed), 5 = (81 - 100% extremely disturbed). The point scale followed a modified Anderson and Currier approach (1973) to accommodate a combined forms of disturbance and the percent i.e., 0-20% was in reference to a bare ground without vegetation cover in each particular sampling plot. One transect of 3km long was established in each study site and eight plots of 20 m x 50 m per transect were established at an interval of 100 m making at total of 36 plots equivalent to a total area of 3.6 ha. Trees with ≥10 cm diameter at breast height (DBH), which is equivalent to 1.3m height above the ground surface, were measured using a tape measure (Stohlgren *et al*. 1995). The same plot of 20 m × 50 m was used to count the number of coppicing shoots (re-sprouts) of all sizes from each tree stump. The percentage of herbaceous cover was estimated in a plot measuring 2 m x 0.5 m nested in 2 m x 5 m plots. Plant species were identified to species level in the field and those found difficult to identify in the field, specimens were collected, pressed and taken to the herbarium in the Department of Botany, University of Dar es Salaam for identification by matching with the preserved herbarium specimens and the nomenclature of plants followed guideline by Turril and Milne-Redhead (1952).

**Assessment of regeneration potential in the study area**

The regeneration potential of trees (poles and seedlings) was done in 2 m x 5 m quadrat nested in 20 m x 50 m. Tree seedlings were plants of <2 cm diameter and saplings were plants of 2–4 cm diameter as recommended by Luoga *et al*. (2002) and Lejju (2004) and the two growth sizes were combined into one composite data as seedling. The poles were stems of 4–9 cm diameter. The number of coppicing shoots (re-sprouts) of all sizes from the remaining stumps after the trees have been exploited were assessed in 20 m × 50 m quadrat.

**Data analysis**

Plant species diversity was determined from raw data by using the Shannon's diversity index (H') (Shannon and Wiener 1948) based on formula below:

$$H' = -\sum_{i=1}^{s} (pi \ln pi)$$

Where:

*pi* = ni/N, the number of individuals found in the $i^{th}$ species as a proportion of the total number of individuals in all the species.

ln = Natural logarithm to base e.

The Shannon-Wiener diversity indices were used to interpret the ecological impacts of anthropogenic activities under the assumptions that individual species are sampled randomly from an even larger population and that each representative species was given an equal chance of being included at every sampling point (Magurran 2004). For that matter it was easy to identify variables that determined the species composition and distribution within the forest natural habitat. The nature of plant species distribution pattern within the degraded Ruvu South Forest Reserve was assessed based on the evenness index (*E*) which was calculated using the formula below:

$$Evenness\ (E) = \frac{H'}{InS}$$

Where H' is Shannon – Wiener Diversity Index and S is the total number of species.

A paired sample t-test was used to compare indices of plant diversity, evenness, richness and the density of regeneration growth sizes (density of trees, poles, coppices and seedlings) between the highly and moderately disturbed sites in Ruvu South Forest Reserve (Zar 1999).

## RESULTS

**Plant species composition**

There was a notable difference in plant species composition between the study sites on the basis of anthropogenic disturbance. A total of 110 plant species distributed among 38 families were recorded in the Ruvu South Forest Reserve (Appendix 1). Among families, Poaceae (22) was represented by the largest number of species followed by Fabaceae (16), Euphorbiaceae (12) Rubiaceae (7), while families Cyperaceae, Burseraceae, Ebenaceae, Colchicaceae, Polygalaceae, Dilleniaceae and Flacourtiaceae were represented by only one species each. Out of 38 families, 22 families were common in both moderate and highly disturbed sites while 11 families were recorded in the moderately disturbed site and 5 families were recorded in the highly disturbed site. Among widely distributed trees in the moderately disturbed site included *Holarrhena pubescens, Hymenocardia ulmoides, Millettia micans, Ochna mossambicensis, Pseudolachnostylis maprouneifolia, Pteleopsis myrtifolia* and *Strychnos madagascariensis*, whereas *Albizia versicolor*, *Pteleopsis myrtifolia, Pterocarpus angolensis*, *Antiaris toxicaria, Diplorhynchus condylocarpon* and *Terminalia kaiserana* dominated in the highly disturbed site. Shrubs and poles common in moderately disturbed site include those from *Diplorhynchus condylocarpon, Markhamia obtusifolia*, *Tetracera boiviniana* and *Xylotheca tettensis* while *Crossopteryx febrifug*a, *Pteleopsis myrtifolia*, *Annona senegalensis* and *Dalbergia melanoxylon* dominated in the highly disturbed site. With regard to grasses, *Urochloa pullulans* and *Themeda triandra* dominated in moderately disturbed site, whereas *Panicum maximum*, *Panicum trichocladum* and *Harpachne schimperi* dominated the highly disturbed site.

**Plant species diversity, richness and evenness**

Plant species diversity (Shannon's indices) ranged from 2.2 to 2.3, richness 14 to 15 per plot and evenness between 0.48 and 0.5 in moderately disturbed sites whereas the diversity indices of 1.8 to 2.2, richness of 10 and12 per plot and evenness of 0.44 and 0.46 in the highly disturbed site. The plant diversity, evenness and richness were significantly higher in the moderately disturbed site than in the highly disturbed site based on t-test ($P < 0.05$) (Table 1).

**Table 1: Plant species diversity, richness and evenness in study sites in Ruvu South Forest Reserve (Mean ± se); p-value 5%; * = significant)**

| Parameter | Moderately disturbed site | Highly disturbed site | t-value | DF | P- value | Conclusion |
|---|---|---|---|---|---|---|
| Diversity | 2.3 ± 0.06 | 2.1 ± 0.08 | 0.0376 | 34 | 0.0376 | * |
| Richness | 14 ± 1.0 | 11 ± 1.0 | 2.202 | 34 | 0.0346 | * |
| Evenness | 0.49 ± 0.014 | 0.45 ± 0.01 | 2.236 | 34 | 0.032 | * |

**Regeneration size class structure of trees in Ruvu South Forest Reserve**

The size class distribution of trees varied between the two studied sites where the highly disturbed site had large number of trees with DBH sizes < 32 cm and trees beyond 40 cm were missing. This was due to the selective exploitation that has occurred in the forest such that it is in the early stages of recovery. The moderately disturbed site had many individuals with DBH sizes < 40 cm and a few representative individuals with DBH beyond 50 cm (Fig. 2).

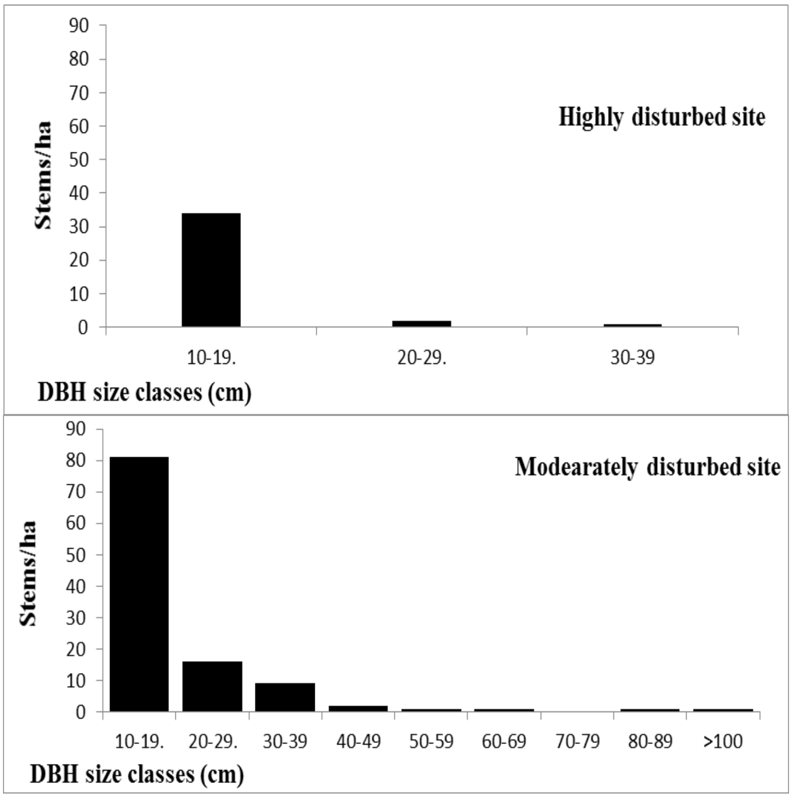


**Figure 2: DBH size class distribution from the study sites in Ruvu South Forest Reserve**

The two study sites were essential dominated by poles/ shrubs and coppices than trees and seedlings. However the trees density was contributed by *Millettia micans, Grewia bicolor, Ochna mossambicensis, Hymenocardia ulmoides, Margaritaria discoidea*, *Holarrhena pubescens* and *Pseudolachnostylis maprouneifolia* in the moderately disturbed site as opposed to *Pterocarpus angolensis, Pteleopsis myrtifolia* and *Albizia versicolor* in the highly disturbed site (Fig 3).

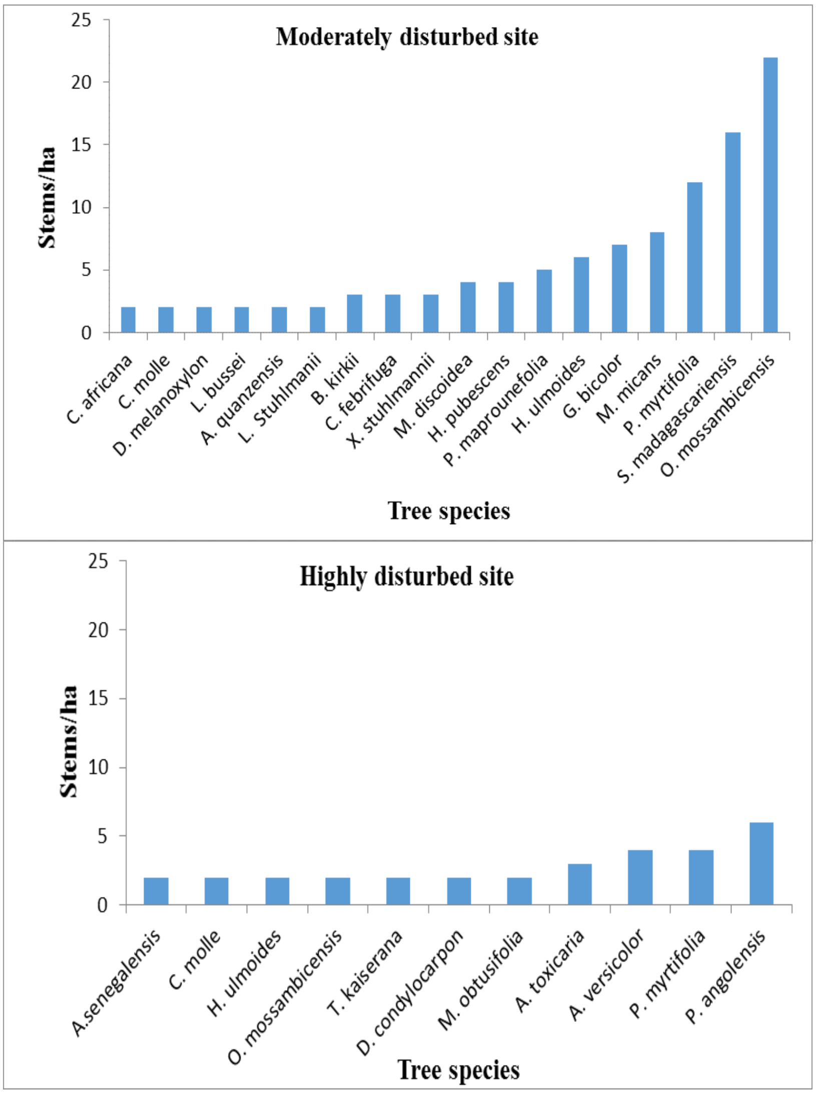


**Figure 3: Stem density of trees (stems/ha) in the moderately and highly disturbed sites of the Ruvu South Forest Reserve.**

It was observed significantly higher density of trees in moderately than in the highly disturbed sites ($t = 2.364$, $DF = 26$, $P < 0.05$), there was no significant differences in poles density between the sites ($t = 1.009$, $DF = 25$, $P > 0.05$) (Fig. 4). The densities of coppices was mostly contributed by *Pteleopsis myrtifolia* (59stems/ha), *Hymenocardia ulmoides* (34 stems/ha), *Holarrhena pubescens* (24 stems/ha), *Grewia conocarpa* (17 stems/ha) and *Crossopteryx febrifuga* (16 stems/ha) in the moderately disturbed site whereas *Pteleopsis myrtifolia* (29 stems/ha), *Xylotheca tettensis* (17 stems/ha), *Markhamia obtusifolia* (16 stems/ha), *Diplorhynchus condylocarpon*

(14 stems/ha), *Pterocarpus angolensis* (12 stems/ha) and *Strychnos madagascariensis* (9 stems/ha) dominated in the highly disturbed sites. However the difference in coppices densities between the two study sites was not significant (t = 0.02613, DF = 72, P = 0.9792) (Fig. 4). A significantly higher density of seedlings represented by *Pteleopsis myrtifolia* (11 stems/ha), *Holarrhena pubescens* (7 stems/ha), *Crossopteryx febrifuga* (7 stems/ha), *Lannea stuhlmanii* (6 stems/ha), *Strychnos madagascariensis* (6 stems/ha), *Millettia usaramensis* (4 stems/ha) and *Millettia micans* (4 stems/ha) was observed in the moderately disturbed than that in highly disturbed sites (t = 2.09, DF= 32, P = 0.0446) which was highly represented by *Pteleopsis myrtifolia* (4 stems/ha), *Antiaris toxicaria* (3 stems/ha) and *Diplorhynchus condylocarpum* (2stems/ha) (Fig.4).

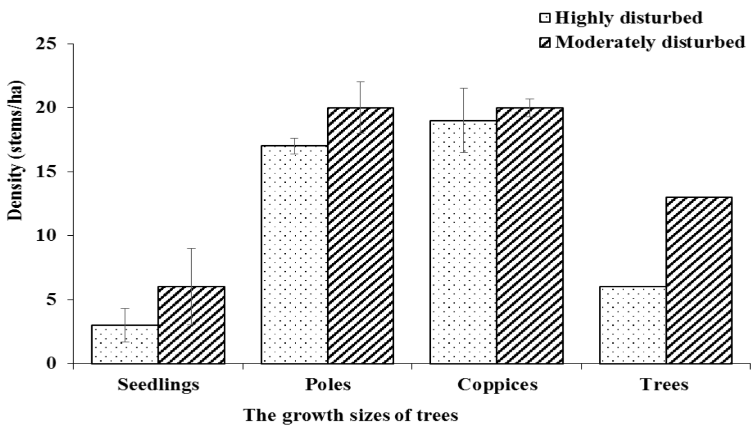


**Figure 3. The regeneration growth size structure of trees**

## DISCUSSION

### Variation in plant species composition within the forest

A number of studies have pointed out on the negative impacts of various human activities (charcoal, poles, timber, firewood collection and forest fires) in plant communities of coastal forests in Tanzania (Burgess and Clarke 2000, URT 2000, Shaforth *et al*. 2002, Kaale 2003, Ahrends 2005, Mligo *et al*. 2011, Gwegime *et al*. 2013). This study cannot dwell far from this phenomena because Ruvu South Forest is one among the remaining coastal forest's fragments in the region. Data from this study provides evidence on the negative impacts of the aforementioned activities on plant species composition, diversity and the capacity of woody plants to regenerate in natural habitats within the Ruvu Forest South Forest. However a noteworthy differences in plant species composition was observed between the highly and moderately disturbed sites because of the variations in intensities of anthropogenic disturbance (Appendix 1). More pressure on the forest was evidenced at Kifuru village than at Kola sub-village that was disturbed at a moderate level because the former village is located within the forest reserve, making it accessible by the surrounding local communities such that large trees have extensively been exploited. Because of high pressure through human activities, the habitat conditions have been much more vulnerable and heavily degraded and the situation was apparent throughout the forest.

The woody products from Ruvu South Forest Reserve have been the major source of fuel to many villages and the nearby coastal towns over the years that have resulted into its degraded condition**.** The plant communities are characterized with a few small trees, but large cover of grass species (*Panicum maximum*, *Themeda triandra*, and *Panicum trichocladum*) in both moderately and the highly disturbed sites in Ruvu South Forest Reserve. These observations provide evidence that the woody plants are in jeopardy because of the rampant anthropogenic activities all over the study forest. Menaut *et al*. (1995) pointed out that frequent burning in combination with exploitation of trees leaves behind an open ground formation. This allows large amount of light to reach the ground surface that may lead to the development of dense grass cover that makes habitat more susceptible to frequent fires. However, if anthropogenic disturbance would not have continued in Ruvu South Forest, it could have permitted the development of woody plants cover that could provide shade on the ground surface to promote tree seedlings establishment that perpetuates the existence of a typical coastal forest.

Changes in plant species composition compared to the previously studies have been apparent in the Ruvu South Forest Reserve. Burgess and Clarke (2000) reported the existence of *Drypetes arguta, Ficus tremula, Oldefieldia somalensis, Zanthoxylum hotzianum, Haplocoelum foliolosum, Acacia adenocalyx, Gardenia transvenulosa, Combretum illairis* and *Ritchiea capparoides* in Ruvu South Forest Reserve. These plant species were not observed in the study area and these changes may have been caused by the impacts of anthropogenic activities that have been in the forest over the years. Because of high intensity of anthropogenic disturbance that modified natural habitat conditions, indigenous plants have failed to regenerate in the impacted area resulting into a degraded forest. Mwasumbi *et al*. (1994) pointed out that, some plant species may be missing in the coastal forests because of anthropogenic disturbance caused by repeated fires and widespread forest clearance. The above mentioned plant species which are coastal forest endemic (Clarke and Dickinson 1995) have disappeared in Ruvu South Forest Reserve because of destructions of their natural habitats caused by anthropogenic activities.

**Plant species diversity, richness and evenness**

The ecological characteristics of tropical forests' ecosystem based on diversity indices and the way they have been influenced by the environmental variables have been reported in various studies (Kent and Coker 1992, Magurran 2004,). Kent and Coker (1992) pointed out that Shannon's diversity indices in most forest ecosystems ranges between 1.5 and 3.5. Wilder *et al*. (1998) reported the species diversity indices of 1.68 and 2.75 in the heavily and the least disturbed parts of Taita Hill Forests, respectively. The observed diversity index values in Ruvu South Forest Reserve that were within the range of 2.0 and 2.3 implies that the forest is still ecologically rich and diverse in plant species and regardless of high level of anthropogenic disturbance it has suffered. However the observed significant differences in plant diversity, richness and evenness among sampling sites was caused by variation in intensities of disturbance pressure within Ruvu South Forest Reserve (Table 1).

Pickett and White (1985) and Zhu *et al*. (2004) pointed out that species diversity is often higher when the disturbance is at intermediate intensity. Similarly Ndangalasi, (1997) pointed out that, moderate disturbance regimes create gaps in climax plant communities where natural regeneration increases plant species diversity. Sagar *et al*. (2003) pointed out that a prolonged intense anthropogenic disturbance caused the decline in species diversity and changed plant species composition and resulted into a degraded forest. However, extensive cutting of trees in Ruvu South Forest Reserve has significantly reduced plant species diversity particularly in the highly disturbed site such that only a few individuals of the most valuable timber trees such as *Afzelia quanzensis*, *Pterocarpus angolensis* and *Baphia kirkii* remained. Similar observations have been reported by Malambo and Syampungani (2008) on the Miombo woodlands of Zambia where heavy logging of *Pterocarpus angolensis, Afzelia quanzensis, Dalbergia melanoxylon* and *Isoberlinia angolensis* contributed to their exploited conditions. The continued unabated anthropogenic activities in Ruvu South Forest Reserve, will make more plant species to become completely exhausted. The above named valuable timber tree may reach to a point of being unable to constitute a viable population which makes them unable to regenerate and attain their reproductive stage.

Because of the variation in the levels and intensity of disturbances, the moderately disturbed sites recorded a significantly large number of plant species (richness) and evenness than it was in the highly disturbed site (Table 1, Appendix 1). The ecological condition with regard to the moderate impacts of anthropogenic may be supported by an intermediate disturbance theory; mild disturbance provides greater opportunity for species turnover, colonization and persistence of high species richness (Connell 1978). Since none of the forest parts is undisturbed but to moderate and heavily disturbed condition, the former condition promoted high plant species richness than the heavily affected plant communities. The uncontrolled fires have affected much of the forest by killing a number of plant species and the impacts were evident in the highly disturbed site that recorded significantly low plant species richness. Plant species evenness was significantly affected by the anthropogenic disturbance because of the selective exploitation of some trees or destruction of plant species habitat (Table 1). The selective removal of some species limits its distribution pattern (Mligo *et al*. 2009) or degradation of plants habitat may contribute to its limited dispersion resulting into low species evenness. The unevenly distributed trees within Ruvu South Forest Reserve is the result of over exploitation and fragmentation of natural habitats and have promoted to a non-random dispersion of plant species.

**The impacts of disturbance on trees regeneration size structure within the forest**

The size class distribution among trees provides an indication of the dynamics in plant population structure and composition (Newbery and Gartlan 1996). It also provides the regeneration status that can be used to predict the future changes in plant community composition. The observed higher stem density at small size classes than larger ones implies a successional recruitment for expanding future plant populations in the disturbed area within the forest. Thus trees with small sizes will reach larger diameter sizes under the reduced or absence of any form of anthropogenic disturbance within the study forest. This observation has been strongly supported by Kumlachew *et al*. (2003), who acknowledges the significance of small sized individuals of trees as a reserve for replacing old individuals. The large difference in size class structures of trees between the two studied sites is related to the different levels of anthropogenic disturbances (Fig. 2). Exploitation of large and mature trees in the highly disturbed site might have resulted into a population being characterized by individuals with small diameter sizes dominated with poles and shrubs. Luoga *et* *al*. (2000) and Monela *et al*. (2003) pointed out that majority of low-income families in urban areas rely heavily upon charcoal while the rural people depend entirely on firewood for all their energy need for cooking and other uses and this has negative impacts on the vegetation structure. Low density of adult trees in the study sites could be related to the extraction of large–sized trees for fuel wood and charcoal in Ruvu South Forest Reserve (Fig. 3). These activities destroy mature and young trees and consequently suppressing the forest capacity to regenerate (Chapman and Chapman 1997). Lathrop *et al.* (1989) reported low density of *Quercus engelmannii* which was less than 30 cm DBH because of the early mortality caused by desiccation. The observed DBH size classes of 10 - 30 cm in this study (Fig. 2) was contributed by anthropogenic disturbances that interfered natural regeneration. Regardless of the major difference in larger size trees between the two sites, they both have representative small size trees that may result into the forest recovery through natural regeneration only if anthropogenic disturbance stops.

The intensive disturbances in Ruvu South Forest Reserve contributed to low stem density of trees as opposed to high density of poles and coppices in both the highly and moderately disturbed sites (Fig. 3). The Kifuru site was more exposed to high level of anthropogenic disturbance and subsequently recorded low tree density than in the cola site which was at the moderately disturbed condition. The overexploited condition in this site is caused by an ever increased demand for woody materials by the nearby coastal towns such as Mlandizi, Kibaha, Mkuranga and Dar es Salaam City. The exploitation of trees promoted high densities of shrubs and herbaceous cover because of the reduced competition for light with trees. This can be supported by observation by Pooja *et al.* (*2*010) on the cause of low stem density in heavily disturbed area. The ongoing exploitation pressure in the study forest may have resulted into shift of the existing plant communities from clumped to scattered dispersion patterns associated with the decrease in stem density similar to the observation in tropical forests by Sagar *et al*. (2003). Over representation by *Pteleopsis myrtifolia, Strychnos madagascariensis, Grewia bicolor* and *Albizia versicolor* in the disturbed forest shows that these plants are not preferred because of low use value by the local communities.

The mechanisms through which a plant species community recover from various forms of disturbance have been discussed by a number of authors (Chidumayo and Frost 1996, Chidumayo 1997, Rocky and Mligo 2012). The observed non-significant difference in densities of seedlings between the two study sites implies that every part of the forest is threatened from recovery through recruitment at lower growth sizes. However a more represented large size trees in the moderately disturbed site indicated the potential it contains for the survival of the forest species. These trees may contribute large quantity of viable seeds that form seedlings under favourable conditions compared to those in heavily degraded site. Lieberman and Li (1992) pointed out that some African forests have high seedling densities in the understory than in exposed open sites. It was regarded that the understory parts of a few remaining trees in moderately disturbed site have persistent moist conditions favourable for seed germination and performance of seedlings than it was observed in the heavily degraded site. The heavily disturbed site have extensive open canopy plant communities with largely exposed soils that subsequently lose moisture and become unable support seedling establishment. This affected the capacity of trees to regenerate naturally in heavily disturbed habitats resulting into low woody stem density.

The successful regenerating species such as *Millettia micans, Holarrhena pubescens, Crossopteryx febrifuga, Lannea stuhlmanii* and *Millettia usaramensis* under moderately disturbed conditions attributed to higher seedling density than those contributed by the surviving *Pteleopsis myrtifolia, Antiaris toxicaria* and *Diplorhynchus condylocarpon* under heavily degraded conditions within the forest. Jorge *et al*. (2007) pointed out that damages caused by logging practices reduce the recruitment of seedlings. The observed limited seedling recruitment under heavily disturbed conditions resulted into negative impacts on composition and abundance of trees with plant communities.

Studies by Swaine *et al.* (1990), Swaine (1992), Chidumayo (1993) reported on the significance of natural regeneration through coppices in tropical forests and the way they are affected by various forms of disturbance. The remaining tree cut stumps in moderately disturbed site coppiced successfully because the anthropogenic activities have not completely suppressed this method of natural regeneration. However, the absence of significant differences in the density of coppiced between moderate and heavily degraded sites implies that all parts of the forest have been equally impacted through anthropogenic disturbance. The remaining stumps of the exploited trees are exposed to the sunlight that stimulates meristem tissues to coppice. Chidumayo (1993) and Sapkota *et al*. (2009) on their separate studies pointed out that disturbance through selective logging creates canopy gaps that permit penetration of sunlight and increase soil temperature while reducing competition for water and nutrients for the established coppices in heavily impacted habitats. The observed low coppices density in heavily disturbed sites in Ruvu South Forest Reserve was most probably caused by the increased in the pressure from anthropogenic activities that affected some tree stumps beyond the ability to establish coppices. Disturbance made large forest parts to be unfavourable for trees to regenerate through seedling establishment such that the exploited trees regenerated mostly through coppicing. *Holarrhena pubescens* and *Millettia micans* species were among trees that successfully regenerated through coppicing in the moderate disturbed site but failed under heavily disturbed conditions.

## CONCLUSION

It has been observed that anthropogenic activities have contributed to the variation in plant species composition, diversity and affected the overall regeneration structure in most parts of the degraded Ruvu South Forest Reserve. The intensive disturbances reduced plant species diversity, richness and resulted into uneven distribution of some plant species in the forest. The current level of indigenous trees regeneration indicated an early stage of the forest recovery from disturbance in both sites, although the density of seedling and coppices to date has continued being suppressed by the aforementioned disturbances within the already degraded Ruvu South Forest Reserve. A coordinated effort is required to stop further destruction and concomitant loss of plant biodiversity within the forest. Being among the few remaining coastal forest fragments, protecting the Ruvu South Forest Reserve will make it be part of efforts in place to conserve coastal forests of Tanzania. Since the local community has contributed to the degraded condition of the forest, they need to be the central players in the ongoing efforts to the conservation management of coastal forest.

## ACKNOWLEDGEMENTS

The author is indebted to Gwilage Donald an MSc students who worked hard in the field during data collection and the support from Mr Haji Suleiman in plant species identification in the field and the herbarium.

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